CLAIMS

1. A shape measuring device, characterized by comprising:

a measuring head moved along a guide rail;

first position detection means for detecting the positions of the measuring head on the guide rail, using a predetermined position on the guide rail as a reference position, from the reference position;

second position detection means for detecting the position in a world coordinate system of the measuring head on the guide rail;

means for storing in a storage device each of the positions of the measuring head on the guide rail using the predetermined position on the guide rail as the reference position and a corresponding position in the world coordinate system with the positions correlated with each other;

measurement means for detecting the position of the measuring head by the first position detection means at each of measuring positions on the guide rail as well as finding the coordinates in a measuring head coordinate system of a measuring point on an object to be measured using the measuring head; and

means for converting the coordinates in the measuring head coordinate system of the measuring point on the object to be measured, which are found at each of the measuring positions on the guide rail, into coordinates in the world coordinate system on the basis of a position in the world coordinate system, corresponding to each of the measuring positions on the guide rail, which is stored in the storage device.

2. The shape measuring device according to claim 1, characterized in that

the measuring head comprises

light irradiation means for irradiating the object to be measured with a light flux, and

imaging means for imaging the measuring point on the object to be measured which is irradiated with the light flux from the light irradiation means.

SUB A17

3. The shape measuring device according to either one of claims 1 and 2, characterized in that the measuring head comprises driving means for being moved along the guide rail.

4. The shape measuring device according to any one of claims 1, 2, and 3, characterized in that

the second position detection means comprises measuring head imaging means for imaging the

measuring head from the predetermined position, and

means for detecting the position in the world coordinate system of the measuring head on the basis of an image obtained by the imaging in the measuring head imaging means.

SUB A1 cont'd

5. The shape measuring device according to claim 4, characterized in that the measuring head imaging means is constructed so as to be attachable and detachable to and from the main body of the shape measuring device.

SUB A27

6. The shape measuring device according to any one of claims 1, 2, 3, 4, and 5, characterized in that the guide rail takes such a shape that the distance thereof from the object to be measured is approximately constant.

7. The shape measuring device according to claim 6, characterized in that the object to be measured is a foot, and the guide rail takes an oblong shape having a long axis in a direction from the heel to the tiptoe of the foot which is the object to be measured.

8. The shape measuring device according to claim 7, characterized in that the guide rail takes a shape tapered from the tiptoe to the heel of the foot which is the object to be measured.

9. A shape measuring device comprising a measuring head for measuring the shape of an object to be measured which is placed on a measuring stand, position detection means for detecting the position of the measuring head, and operation means for finding a three-dimensional shape of the object to be measured on the basis of outputs of the measuring head and the position detection means, characterized in that

a mirror for reflecting the object to be measured is disposed on the measuring stand.

10. The shape measuring device according to claim 9, wherein the position detection means detects the position of the measuring head by a stereo method using two cameras.

SUB A37

11. The shape measuring device according to either one of claims 9 and 10, characterized in that

the measuring head comprises

light irradiation means for irradiating the object to be measured with a light flux, and

imaging means for imaging a measuring point on the object to be measured which is irradiated with the light flux from the light irradiation means, to pick up a real image of the object to be measured and a virtual image of the object to be measured which

is reflected on the mirror.

12. The shape measuring device according to any one of claims 9, 10, and 11, characterized in that the mirror has a light reflective surface formed on its surface.

13. The shape measuring device according to claim 12, characterized in that

the operation means comprises

first means for finding the coordinates in a measuring head coordinate system of each of the measuring points on the basis of the coordinates of the measuring point on an imaging screen of the imaging means and an equation expressing a plane representing the light flux emitted from the light irradiation means,

second means for converting the coordinates of each of the measuring points which are found by the first means into coordinates in a world coordinate system on the basis of the results of the detection by the position detection means, to find a three-dimensional shape corresponding to the rear image of the object to be measured and a three-dimensional shape corresponding to the virtual image of the object to be measured which is reflected on the mirror,

third means for finding an equation, in the world coordinate system, expressing a light reflective surface of the mirror,

fourth means for finding a three-dimensional shape which is symmetrical to the three-dimensional shape corresponding to the virtual image about the light reflective surface on the basis of the equation expressing the light reflective surface of the mirror, and

fifth means for synthesizing the three-dimensional shape which is symmetrical to the three-dimensional shape corresponding to the virtual image about the light reflective surface and the three-dimensional shape corresponding to the real image of the object to be measured, to find a three-dimensional shape of the object to be measured.

14. The shape measuring device according to claim 13, characterized in that

means for finding the equation expressing the light reflective surface of the mirror comprises

means for measuring the coordinates of three or more points on the light reflective surface by a stereo method using two cameras, and

means for finding an equation expressing the

light reflective surface on the basis of the obtained coordinates of the three or more points on the light reflective surface.

15. The shape measuring device according to claim 13, characterized in that

means for finding the equation expressing the light reflective surface of the mirror comprises

means for imaging an opaque thin plate using the measuring head in a state where the thin plate is placed on the light reflective surface, to extract coordinates in the measuring head coordinate system of three or more points for specifying a plane of the thin plate,

means for converting the obtained coordinates in the measuring head coordinate system of the three or more points into coordinates in the world coordinate system on the basis of the results of the detection by the position detection means, and

means for finding an equation, in the world coordinate system, expressing the plane of the thin plate on the basis of the obtained coordinates in the world coordinate system of the three or more points.

SUB A7 16. The shape measuring device according to any one of claims 13, 14, and 15, ~~characterized by~~

comprising guide means for regulating the posture of the measuring head such that the light flux irradiated from the light irradiation means in the measuring head is perpendicularly emitted to the light reflective surface of the mirror.

17. The shape measuring device according to any one of claims 13, 14, 15, and 16, characterized in that the guide means regulates a moving path of the measuring head.

18. The shape measuring device according to claim 17, characterized by comprising driving means for moving the measuring head along the guide means.

19. The shape measuring device according to claim 18, characterized by comprising a case covering the whole of the moving path of the measuring head.

20. The shape measuring device according to claim 19, wherein the case comprises an opening into and from which the object to be measured is to be inserted and extracted.

21. The shape measuring device according to claim 20, characterized in that a cover composed of an elastic member is provided in the opening of the case, the cover comprising a notch into and from which the object to be measured is to be inserted

and extracted.

SUB A57 22. The shape measuring device according to any one of claims 9, 10, and 11, characterized in that the mirror comprises a light reflecting plate having a light reflective surface formed on its surface and a transparent plate formed on the light reflecting plate.

23. The shape measuring device according to claim 22, characterized in that

the operation means comprises

first means for finding, with respect to a measuring point on the real image of the object to be measured, the coordinates in the measuring head coordinate system of the measuring point on the basis of the coordinates of the measuring point on the imaging screen of the imaging means and the equation expressing the plane representing the light flux emitted from the light irradiation means,

second means for finding, with respect to a measuring point on the virtual image of the object to be measured which is reflected on the mirror, the coordinates in the measuring head coordinate system of the measuring point on the basis of a coordinate value obtained by correcting the coordinate value of the measuring point on the imaging screen of the

imaging means in consideration of the amount of refraction of the transparent plate in the mirror and an equation obtained by correcting the equation expressing the plane representing the light flux emitted from the light irradiation means in consideration of the amount of refraction of the transparent plate in the mirror,

third means for converting the coordinates of each of the measuring points which are found by the first means and the second means into coordinates in the world coordinate system on the basis of the results of the detection by the position detection means, to find a three-dimensional shape corresponding to the real image of the object to the measured and a three-dimensional shape corresponding to the virtual image of the object to be measured which is reflected on the mirror,

fourth means for finding an equation, in the world coordinate system, expressing the light reflective surface of the mirror,

fifth means for finding a three-dimensional shape which is symmetrical to the three-dimensional shape corresponding to the virtual image about the light reflective surface on the basis of the equation expressing the light reflective surface of the

mirror, and

sixth means for synthesizing the three-dimensional shape which is symmetrical to the three-dimensional shape corresponding to the virtual image about the light reflective surface and the three-dimensional shape corresponding to the real image of the object to be measured, to find a three-dimensional shape of the object to be measured.

24. The shape measuring device according to claim 23, characterized in that

means for finding an equation expressing the light reflective surface of the mirror comprises

means for measuring the coordinates of three or more points on the measuring stand on which the mirror is placed by a stereo method using two cameras, and

means for finding the equation expressing the light reflective surface on the basis of the obtained coordinates of the three or more points on the measuring stand.

SUB A6 7

25. The shape measuring device according to any one of claims 22, 23, and 24, characterized by comprising guide means for regulating the posture of the measuring head such that the light flux

irradiated from the light irradiation means in the measuring head is perpendicularly emitted to the light reflective surface of the mirror.

ADD B17